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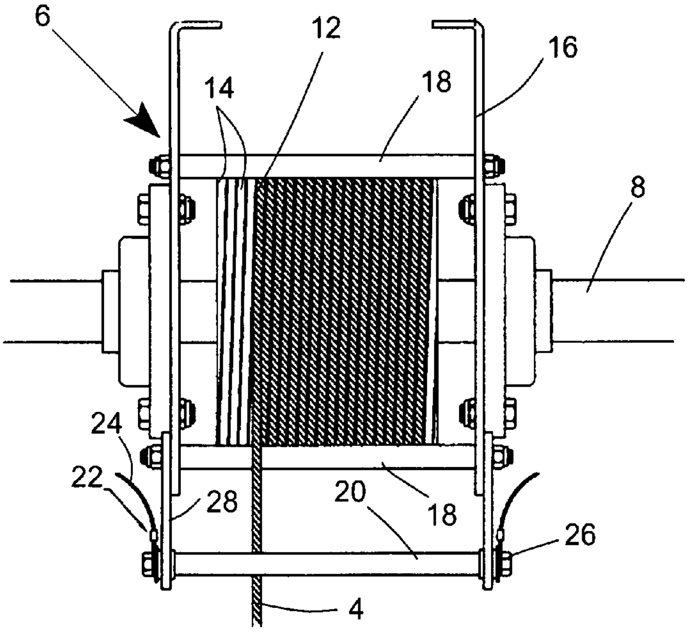

(57) Abstract: A slack cable detection system includes a conductive member deployable adjacent a normally tensioned metallic cable. The conductive member can comprise a bar deployed on a side of the tensioned metallic cable toward which the cable will bow, due to the memory of the cable, when the cable becomes slack. The slack cable detection system is suspended from a cable drum about which a cable is wound. Multiple cable drums are mounted on a rotating shaft and the cables are attached to a suspended device, such as a scenic drop used in theatres or other displays of the type often used on cruise ships.

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SCENIC DROP SLACK CABLE DETECTION SYSTEM

CROSS REFERENCE TO PRIOR CO-PENDING APPLICATION

This application claims benefit of the filing date of prior co-pending US Provisional Patent Application Serial Number 60/851,558 filed October 16, 2006.

FIELD OF THE INVENTION

A system for preventing entanglement of cables used to raise and lower scenic drops of the type used in theaters employs a detection apparatus for detecting slack in cables used to raise and lower the drops. The system detects initial deflection of cables wound around cable drums before significant damage is done to the drops and before the cables become entangled so that significant maintenance is required.

BACKGROUND OF THE INVENTION

In theaters, there are many situations in which hard scenic drops are employed instead of roll drops. A roll drop is a rotating roll that unwinds a decorative backdrop to lower the roll drop to the stage floor. The roll drop, which is suspended overhead, can then be rewound to remove the roll drop from view. A hard scenic drop is similar to a panel, and a decorative scene is normally mounted on an aluminum frame. The entire frame is then lowered and raised, but it is not rolled.

Scenic drops are normally connected by cables to one common drive shaft upon which several cable drums are mounted. Typically, five cable drums are evenly spaced over the width of the scenic drop or the length of the shaft. Each cable drum is associated with a single cable that is attached to the scenic drop. One end of each cable is attached to the scenic drop and the other end is attached to the corresponding cable drum. Normally the drums have spiral grooves in which a corresponding cable is deployed when wound around the drum. These cables normally comprise ¼ inch stainless steel cable, and the cables are normally under tension. In normal operation, these cables will wind and unwind in the spiral drum grooves as the scenic drops are lowered and raised.

Although scenic drops of this type can be used in a number of different applications, one typical use of such scenic drops is on cruise ships. In such applications, multiple scenic drops are stacked side by side, so that as one scenic drop is raised another may be lowered or merely exposed when already in place. Typically the side edges of scenic drops are loosely restrained in vertical channels so that the scenic drops do not sway when raised or lowered. However the scenic drops tend to be closely spaced, and in many applications a large number of cables are closely spaced.

There are many situations in which slack is introduced into one or more of the cables as it is raised or lowered. This is especially true when scenic drops are employed on cruise ships. The cables can become slack when the drop is lowered onto an object that has not been removed from the stage floor or when one piece of decorative scenery attached to a drop snags an adjacent drop and picks up that drop when it is being raised. When a cable becomes slack, it can hang up on adjacent scenic drops or cables or on other structures that may be adjacent the slack cable. The remainder of the cable attached to a particular drop may still be under tension, and may still be sufficient to raise or lower the scenic drop. However, when the slack cable becomes entangled with another device or when the slack cable is forced from the grooves in the drums, the slack cable can bind, making it impossible to continue to raise or lower the corresponding scenic drop, and possibly interfering with the operation of other scenic drops. In many situations, the slack cable can be dislodged from the spiral cable grooves and become wedged between the cable drum and retaining bars, which normally span the cable drums to keep the cable in the spiral groove. However, a considerable amount of force can be transmitted through the stainless steel cables and the cables can force the retaining bars out of position so that the cable becomes wedged between the retaining bars and the ribs forming the sides of the spiral grooves. Once a cable becomes entangled, it then becomes necessary for a service technician to untangle and redeploy or possibly replace the cables, if damaged. This operation, which normally must take place at the elevated position of the cable drums, can take some time during which one or more scenic drops might otherwise be needed in support of entertainment or some other presentation. On cruise ships, theatres or other presentation forums tend to be in constant use, and the inability to properly operate scenic drops may interfere with many of the activities on a cruise ship.

The instant invention provides an effective way to quickly detect a slack cable before it has the chance to become entangled or bind the scenic drop or drops in question. This invention can be employed with existing equipment, and the necessary modifications can be employed to retrofit existing scenic drop and drum assemblies. No significant mechanical modifications are necessary, either to the scenic drop hoist assembly or to the controllers that are commonly used to raise and lower the scenic drops. No software modifications to the control systems are required.

SUMMARY OF THE INVENTION

A slack cable detection system according to this invention includes a stationary conductive member, in the form or a bar or wire, that can be deployed adjacent a normally tensioned metallic cable. The conductive member is positioned on a side of the tensioned metallic cable toward which the cable will bow, due to the memory of the cable, when the cable becomes slack. The stationary conductive member is maintained at a higher voltage relative to ground until contacted by the normally tensioned metallic grounded cable when the cable becomes slack.

This cable slack detection system can be employed to detect of a slack cable suspending a scenic drop or other device. The conductive member can comprise a conductive bar mounted on a cable drum in a position spaced from the path of a cable when in tension. The conductive bar is positioned to engage a cable when slack. An electrical circuit is connected to the conductive bar so that contact of a slack cable with the conductive bar can be detected so that further movement of the cable can be interrupted.

Such a system for deploying a device suspended from cables can include a motor rotating a shaft and cable drums mounted on the shaft and is rotated by the shaft. A cable is wound around each cable drum and is attached to the suspended device. A cable detection unit can be mounted on at least one cable drum for detecting lateral movement of the corresponding cable beyond a normal range of operation. A circuit deactivates the motor when the cable detection unit detects lateral movement of the cable beyond the normal range of operation.

BRIEF DESCRIPTION OF THE DRAWNINGS

Figure 1 is a view of a scenic drop framework mounted on five cables mounted on cable drums on a common drive shaft.

Figure 2 is a view of a scenic drop cable drum showing a single cable deployed around the cable drum and showing a slack cable detection unit mounted on the cable drum.

Figure 3A is a view of one of the slack cable detection bar subassemblies.

Figure 3B is a view of one of the slack cable detection bars.

Figure 4 is a side view of a scenic drop cable drum showing the position of slack cable detection unit relative to a cable on the drum.

Figure 5 is a view of a mounting bracket for the slack cable detection unit.

Figure 6 shows a plurality of side by side scenic drops suspended by hoists. This view shows the relatively close proximity of the side by side drops.

Figure 7 is a wiring schematic showing the main components of the slack detection unit as it is wired to a programmed logic controller.

Figure 8A is a view of a normally open relay that would provide an input to the programmed logic controller.

Figure 8B is a view of a normally closed relay that would be opened by an output from the programmed logic controller.

Figure 9 is a view of the installation of the slack detection system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT.

A scenic drop 2 is suspended by a series of cables 4 extending around cable drums 6 as shown in Figure 1. The scenic drop 2 is of conventional construction. Scenic drop 2 is relatively rigid and consists of a graphic sheet supported by a frame, such as an aluminum frame. Five evenly spaced cables 4 are attached to the scenic drop along the top edge. Each cable is wrapped around a cable drum 6. The cable drums are mounted on a shaft 8 so that rotation of the shaft 8 will either raise or lower the scenic drop 2 as the cables are played out or wound around respective cable drums 6. A motor and gear box subassembly assembly 10 imparts rotation to the shaft 8. This assembly can be referred to as a hoist for each scenic drop In most applications, a plurality of scenic drops are suspended by cables from a plurality of parallel, relatively closely spaced shafts. This close spacing can cause cables to become snagged or hang up.

Figure 2 shows one of the cable drums 6 in more detail. A cable 4 is shown spooled around a corresponding cable drum 6. A series of spiral grooves 14 are formed along the exterior surface 12 of the cable drum. The spiral grooves 14 partially receive the individual cables 4, and under normal operation insure that the cable does not become entangled on the drum 6. A series of retaining bars 18 extend between opposite side plates 16. These retaining bars 18 are spaced from the exterior drum surface 12 by a distance such that only a single cable 4 can fit within each groove 14. Although relatively rigid, these retaining bars 18 are only supported at their ends, so they can be bent if a sufficient side load is applied.

The cables 4 are preferably stranded ¼ inch stainless steel cables, and if a sufficient force is applied to a cable 4 it can push a retaining bar 18 outward, and the cable 4 can become wedged between a retaining bar 18 and the crown of one of the spiral grooves 14. It has previously been assumed that the cables 4 become snagged when they "jump the tracks" formed by the spiral grooves 14 and that this was the reason for most hang ups. Close observation has however revealed that the typical sequence of events is reversed. Normally the scenic drop 2 or a cable 4 first becomes entangled at a location remote from the cable drum 6. One of the cable then becomes slack as the motor 10 continues to rotate the shaft 10 to either deploy or retrieve the cables 4. Eventually sufficient compressive force can be transferred through one stainless steel cable 4 to cause the cable to become wedged between a retaining bar 18 and the exterior drum surface 12.

This invention employs a slack cable detection unit 20 mounted on each cable drum 6 so that a slack cable can be detected before that cable 4 becomes entangled between the cable drum surface 12 and a retaining bar 18. Cable detection unit 20 also detects cable slack 4 before the scenic drops 2 or cables 4 become more seriously entangled by continued movement of the other cables after a first cable is snagged and becomes slack.

The stainless steel cables 4, which are wound around the cable drums 4 have a memory. The cables 4 are always in tension during normal operation. However, when a cable becomes slack, the cable memory will cause the cable to bow outwardly away from the cable drum 4 if not otherwise restrained. It has been noted that a slack cable 4 will move or bow outwardly just below the cable drum 4 where a tensioned cable would otherwise extend vertically along a straight line to the scenic drop 2. Thus a slack cable will not extend along a straight vertical line and will virtually always move outwardly from that straight line in the same direction. The cable detection unit 20 according to this invention takes advantage of this phenomenon to detect slack cable before serious damage is done.

Cable detection unit 20 comprises an electrically conductive detection bar 32 suspended from brackets 28 located on either end of the detection bar 32. The cable detection bar 32 will be spaced from the tangential path normally followed by a tensioned cable. This spacing will be sufficient to avoid inadvertent tripping, but will be close enough to the normal tangential path of a tensioned cable 4 so that detection will occur soon after a cable becomes slack. In the preferred embodiment of this invention, this spacing will be approximately one quarter (¼) of an inch. Each bracket 28 is bolted to one of the retaining bars 18 and extends at an angle relative to the cable 4 so that the detection bar 32 bolted to the opposite end of the bracket 28 will be located outside of the path of a tensioned cable 4.

The conductive bar 18 has tapped holes 34 on opposite ends so that it can be bolted to the brackets 28 on opposite ends. An electrical ring terminal 22 of conventional construction is mounted on opposite ends of the conductive bar 18. Insulating sleeves 30, which can be formed of a material such as Nylon, will electrically isolate the ring terminals 22 from the brackets 28. However, the ring terminals will be in conductive contact with bolts 26, which are in turn screw threaded to conductive bar 32. The ring terminals 22 are in turn crimped to a wire 24. Wires 24 connect all of the slack detection units 20 mounted on cable drums 6 mounted on the same shaft 8. In other words all of the cable detection units 20 mounted on cable drums 4 supporting the same scenic drop are electrically interconnected by wires 24. During normal operation a voltage is maintained on the detection bars of the cable detection units 20. A voltage of 24 DC has been found to be sufficient. The cables 4 are grounded. During normal operation, these grounded cables 4 are not in electrical contact with the cable detection bars 32, which are at an elevated voltage relative to the cables 4.

However, when a cable becomes slack, it will bow outward and come into contact with an adjacent cable detection bar 32. A cable detection bar 32 in contact with a slack cable 32 will then be grounded. Since all of the cable detection units 20 for the same scenic drop are electrically in series, when one cable detection bar 32 is grounded, the corresponding circuit will also be grounded no matter which cable has become slack. When the circuit is grounded by a slack cable a conventional relay (not shown) in this circuit can then be tripped. If this relay is part of a circuit powering the electric motor 10, the motor can than be deactivated and rotation of the shaft 8 can then be stopped, preventing further entanglement of the slack cable, other cables or other components of the scenic drop assemblies. It has been found that slack detection in this manner can shut down the system before cables 4 are wedged on the corresponding cable drums 6. This slack detection system can also allow a service technician to determine where the problem first occurred and remedy that problem before the entanglement becomes even more serious.

Figure 7 is an electrical wiring schematic showing the manner in which the slack cable detection apparatus is connected. A display is included so that an operator can determine when and where one of the cables supporting a drop has become slack. This preferred embodiment can be employed as an add on or retrofit assembly that can be employed with an existing control system for raising and lowering theatrical drops or similar devices, without requiring substantial changes to the existing system.

The control assembly 40 includes a programmable logic controller 50 of generally conventional configuration with a plurality of inputs generate by the slack cable detection unit 20. The programmable logic controller 50 will have outputs to relays 90 that can be placed in the overtravel circuit of the control system for controlling the hoists from which the drops are suspended. Only a single relay 90 for each separate hoist will be added directly to the control system, and it will not be necessary to reprogram the standard hoist control system or any of its components.

Figure 7 shows the manner in which the programmable logic controller can be connected to a slack cable detection unit 20 for a single hoist. Additional slack cable detection units 20 can be added for each additional hoist. The programmable logic controller 50 is powered by line voltage and the individual slack cable detector subassemblies 40 for each hoist are maintained at a signal voltage of 24 VDC in the preferred embodiment of this invention. This signal voltage is low enough to prevent any electrical shocks or fire hazards. A touch screen display 60, on which a slack cable warning can be displayed is also connected to and powered by this low or signal voltage circuit.

A connection 50a to the programmable logic controller 50 establishes a voltage of 24 VDC. A plurality of slack cable sensors 20a, 20b, and 20c, each of the type described in Figures 1-5 is connected to 24VDC through the programmable controller output 50b.

Each slack cable detector subassembly 40 is represented in Figure 7 by four separate lines. A first line containing a series of slack cable detection units or sensors 20a, 20b and 20c is connected to an output 50b on the programmable logic controller 40. From the output 50b the circuit is connected through a 200 ohm resistor which is in turn connected to the sensors 20a, 20b ,20c and to relay 82 in series. Each of the sensors or cable detection units 20a, 20b and 20c are maintained at a voltage of 24 VDC through programmable controller output 50b. This allows voltage to be applied to relay 82 causing it to be energized closing its contact 84. This switches 24 VDC to input 50c indicating that the circuit is normal.

However, when the normally tensioned cable initially becomes slack it will bow outward due to its memory and will come into contact with the adjacent conductive member or bar 32 on the corresponding cable detection unit, 20a, 20b or 20c. At this point the conductive bar will be grounded creating a short circuit that is kept at a low, safe current level by the 200 ohm resistor. The coil 82 of a normally open relay 80, also depicted in Figure 8A, will then be denergized and the relay will be opened. The relay contacts 84 of relay 80 will then be opened so that a signal of 24 VDC will no longer be present at programmable controller input 50c. The controller 50 will be programmed so that when the input 50c is off, the controller output 50d will change state and will energize the relay coil 92 of normally closed relay 90, as represented in Figure 8B. When relay coil 92 is thus energized, the contacts 94 on normally closed relay 90 will open.

Relay 90 is located on an overtravel or emergency stop circuit of the winch control panel of the cable hoist assembly. Relay 90 will open at substantially the same instant as a slack cable engages a conductive bar 32 on one of the cable detection units 20. Relay 90 will then activate a circuit, which would otherwise be activated only when the hoist had reached the end of its travel. When this circuit is activated, the specific hoist would be stopped. Since the corresponding hoist would stop before reaching the limit of its normal travel, the operator could easily determine that the failure was due to the detection of slack cable. A separate relay 90 would be placed in the overtravel or emergency stop circuit, and the particular relay and circuit that is tripped could then be easily detected. The touch screen 60 would provide that information. In practice the hoist on either side of the location of the slack cable detection could also be identified, since the problem which led to the malfunction may be traceable to the interference of adjacent hoists.

Figure 9 shows the manner in which the slack cable detection system according to this invention could be installed and the wiring that would be necessary for this type of installation.

Although the preferred embodiment of this slack cable detection system is used with scenic drops, it should be understood that the same slack cable detection system could be employed with other devices that are suspended from cables and can be lowered or raised by these cables. For instance this cable detection system could be employed in a factory environment.

I CLAIM:

1. A slack cable detection system comprising a stationary conductive member deployable adjacent a normally tensioned metallic grounded cable, the stationary conductive member being deployed on a side of the grounded tensioned metallic cable toward which the cable will bow, due to the memory of the cable, when the cable becomes slack, wherein the stationary conductive member is maintained at a higher voltage relative to ground until contacted by the normally tensioned metallic grounded cable when the cable becomes slack.

2. A cable slack detection system for detection of a slack cable suspending a scenic drop comprising:

a conductive bar mounted on a cable drum in a position spaced from the path of a cable when in tension, the conductive bar being positioned to engage a cable when slack;

an electrical circuit connected to the conductive bar so that contact of a slack cable with the conductive bar can be detected so that further movement of the cable can be interrupted.

3. The slack cable detection system of claim 2 wherein the electrical circuit connects multiple conductive bars deployed adjacent multiple cables suspending a scenic drop.

4. The slack cable detection system of claim 3 wherein a voltage is normally maintained in the circuit so that contact between an cable and an adjacent conductive bar will ground the circuit.

5. The slack cable detection system of claim 2 wherein the conductive bar is suspended from a cable drum around which a cable is wound.

6. The slack cable detection system of claim 5 wherein opposite ends of the conductive bar are attached to brackets extending from a cable drum.

7. The slack cable detection system of claim 6 wherein wires at either end of the conductive bar connect the conductive bar to other conductive bars disposed adjacent other cables.

8. The slack cable detections system of claim 7 wherein each conductive bar has taped holes at opposite ends for securing the conductive bar to the brackets.

9. The slack cable detection system of claim 6 wherein the conductive bar comprises a wire.

10. The slack cable detection system of claim 6 wherein the bracket extends from the cable drums so as to position the conductive bar beyond the path of a tangential tensioned cable extending vertically from the cable drum.

11. The slack cable detection system of claim 2 wherein the slack cable detection bar is suspended from a retaining bar mounted on a cable drum, the retaining bar normally maintaining the cable within grooves on the cable drum.

12. A system for deploying a device suspended from cables comprising:

a motor rotating a shaft;

cable drums mounted on the shaft and rotatable by rotation of the shaft;

a cable wound around each cable drum and attachable to the suspended device;

a cable detection unit on at least one cable drum for detecting lateral movement of the corresponding cable beyond a normal range of operation; and

a circuit for deactivating the motor when the cable detection unit detects lateral movement of the cable beyond the normal range of operation.

13. The system of claim 12 wherein the cable is maintained under tension during normal operation and the cable detection system comprises a slack cable detection system for detecting slack cable.

14. The system of claim 13 wherein the slack cable detection system is mounted on only one side of the normally tensioned cable.

15. The system of claim12 wherein the cable detection unit comprises a conductive bar suspended from the cable drum.

16. The system of claim 12 wherein the cables have a memory which imparts lateral deflection to the cables when the cables become slack.

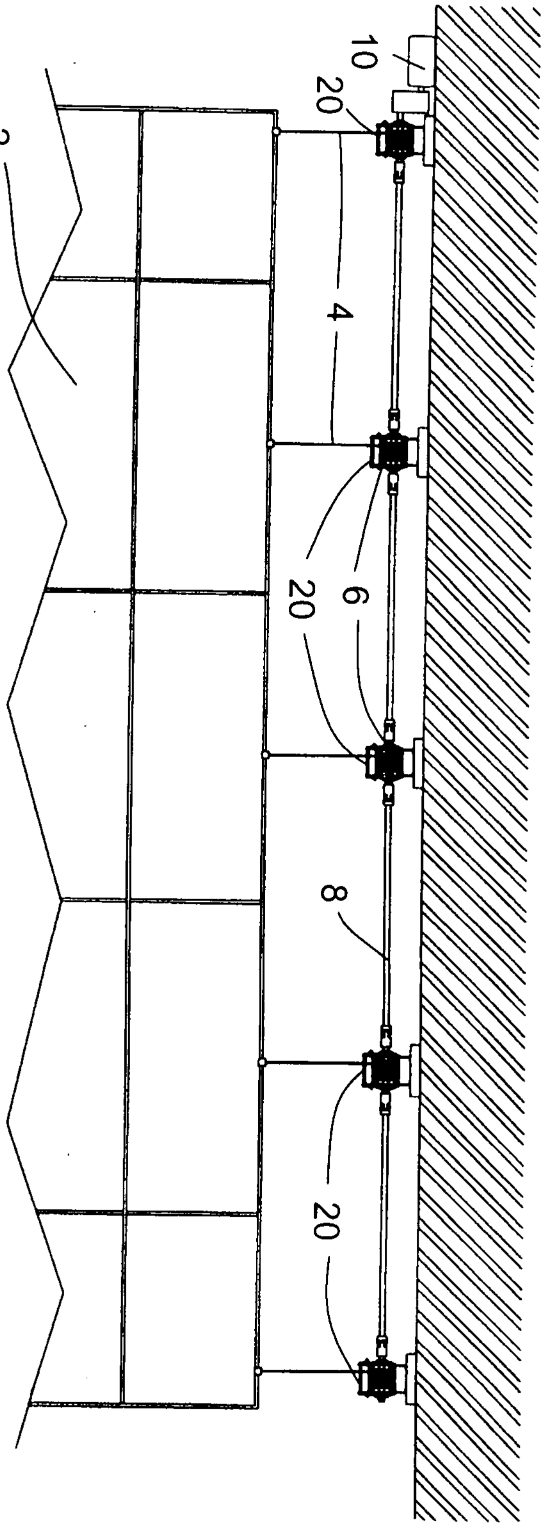
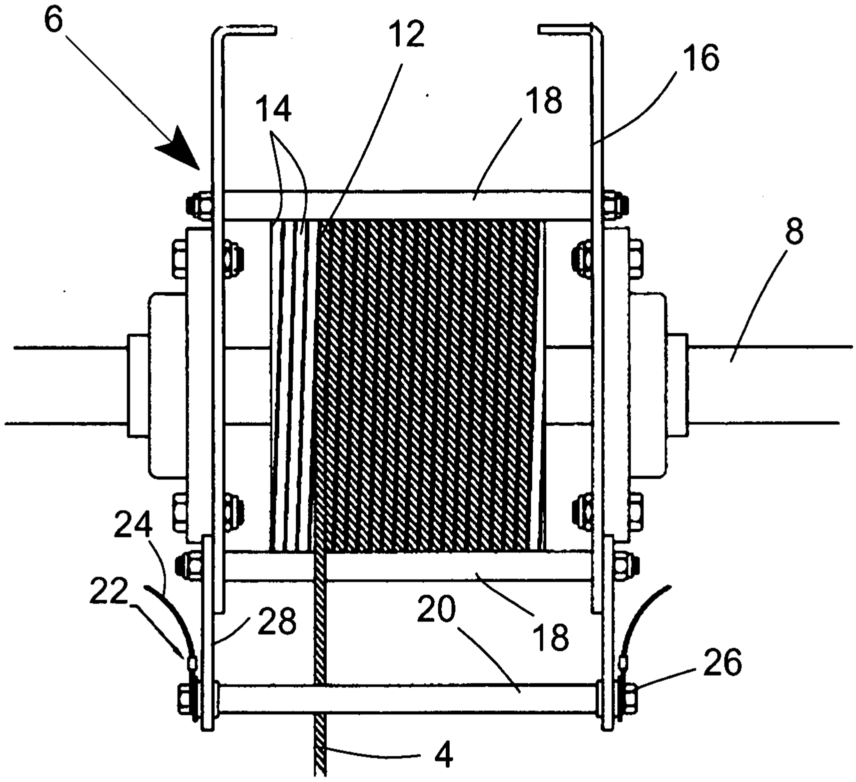


FIG 1

FIG 2



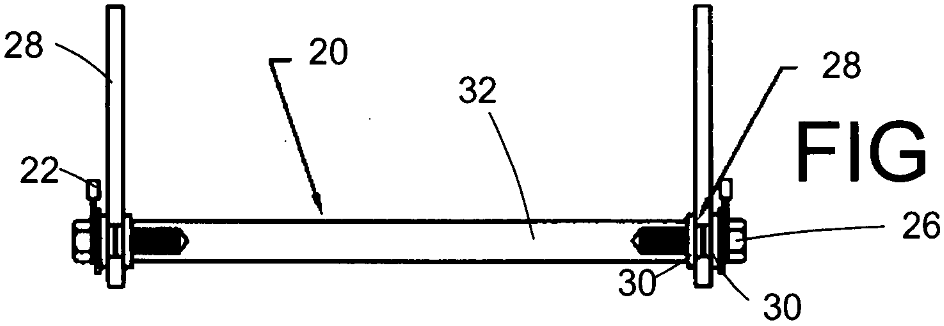


FIG 3A

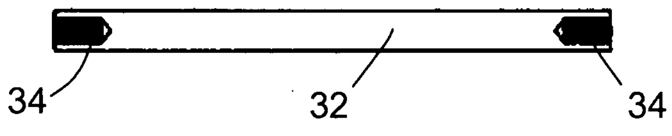


FIG 3B

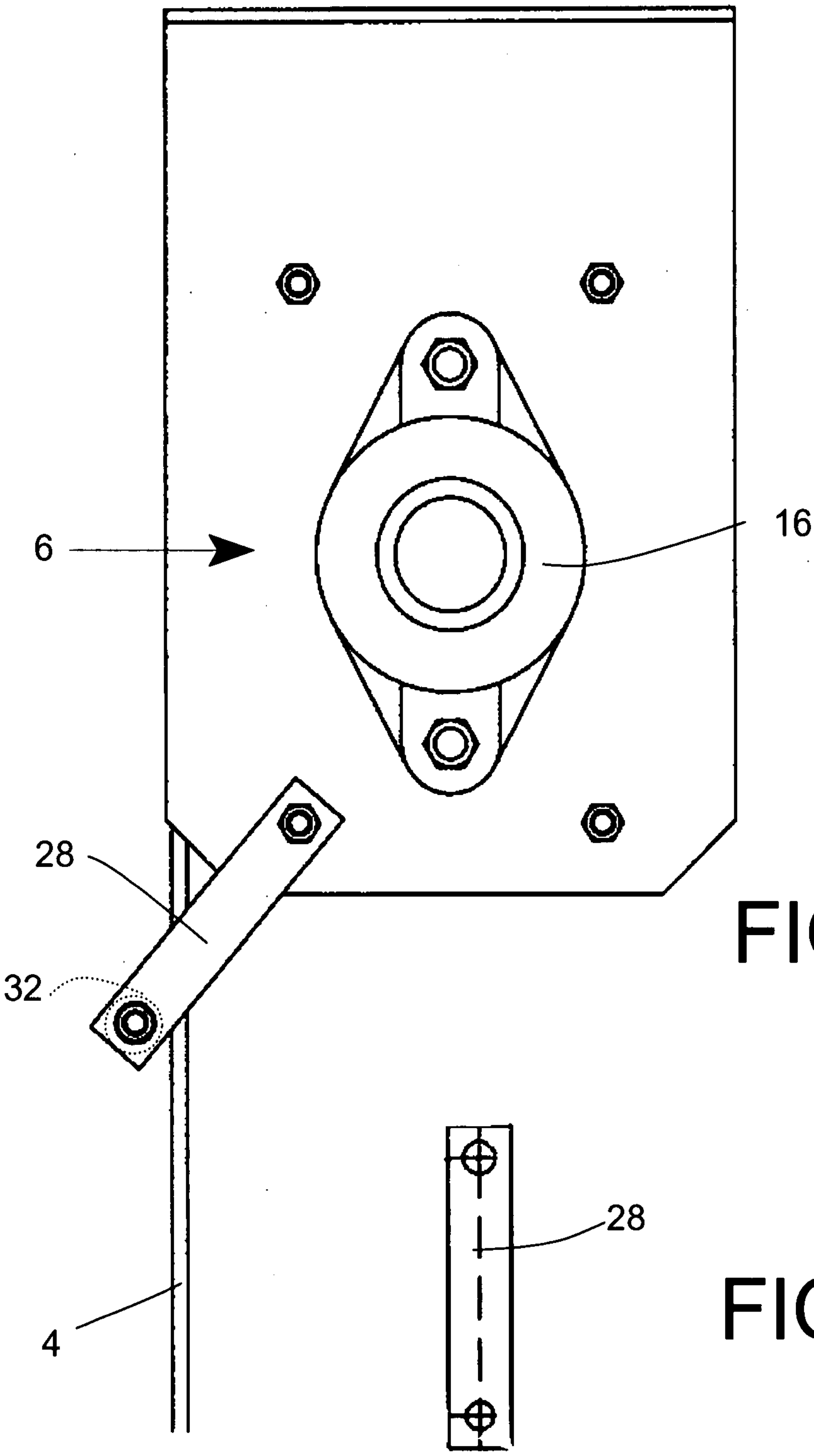


FIG 4

FIG 5

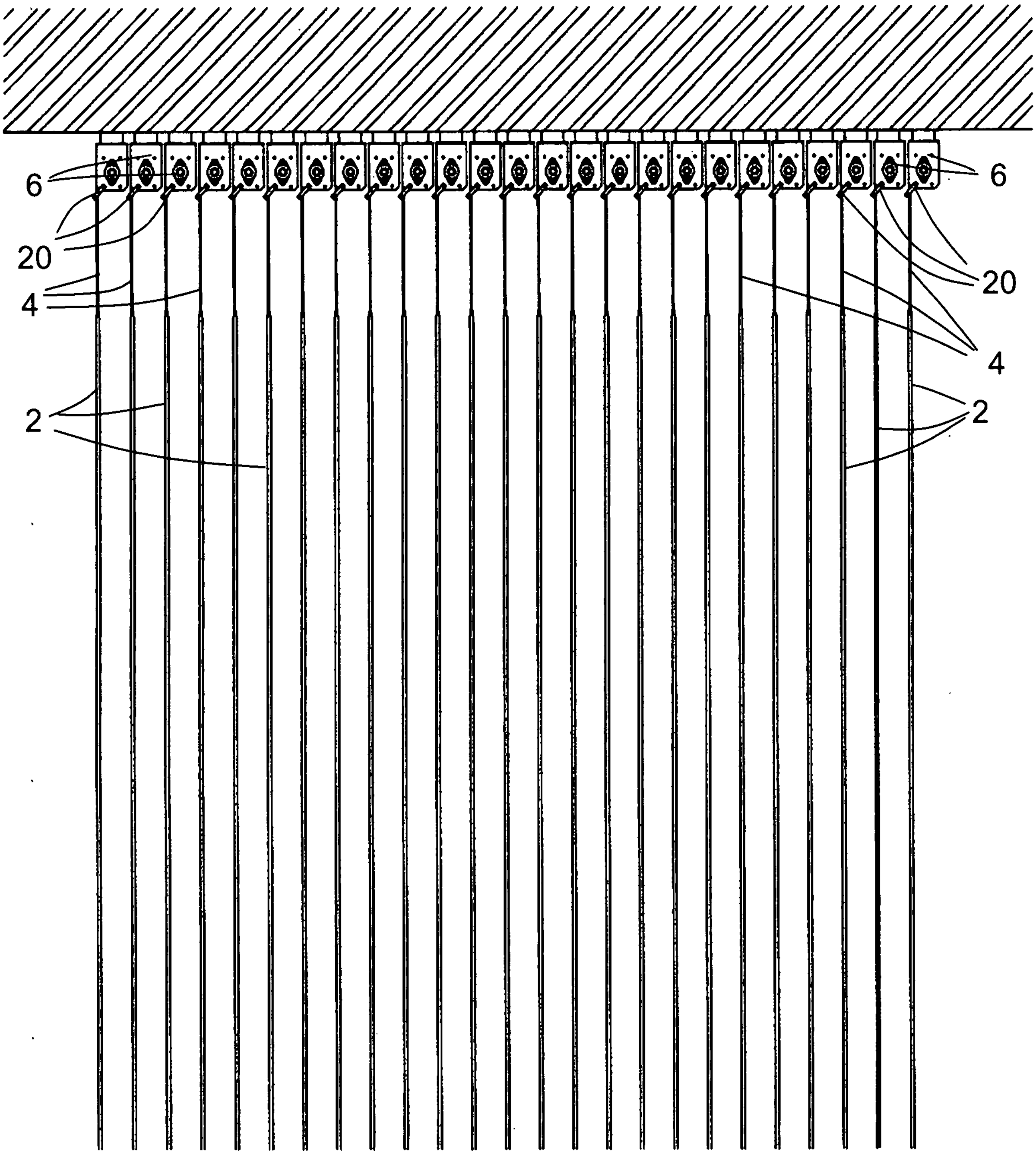


FIG 6

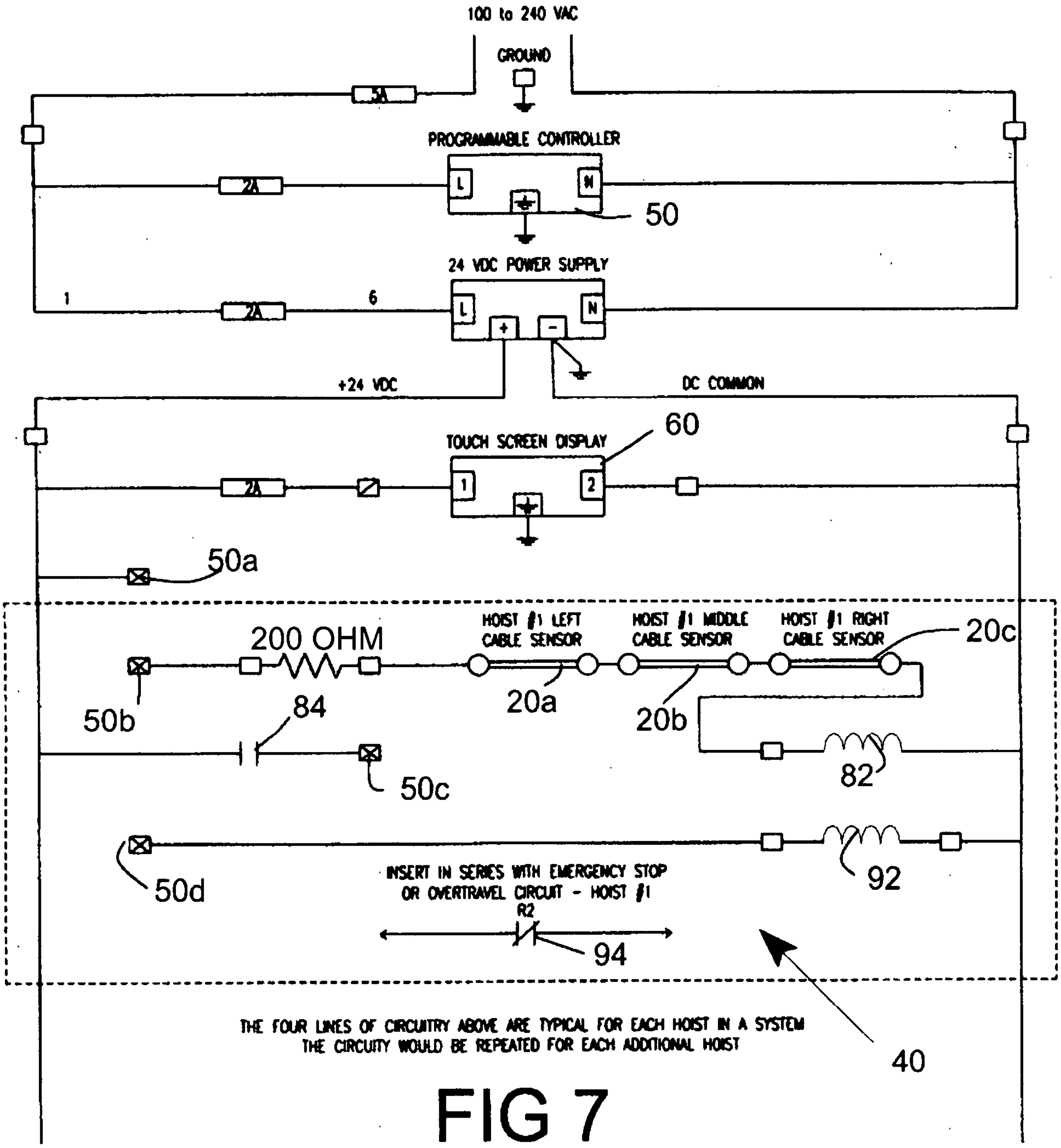


FIG 7

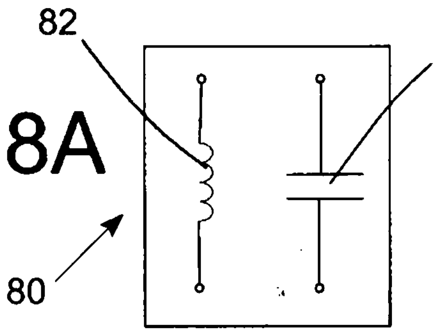


FIG 8A

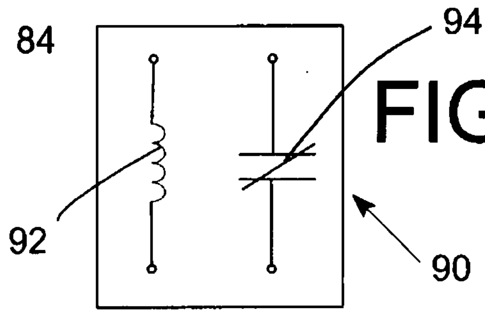


FIG 8B

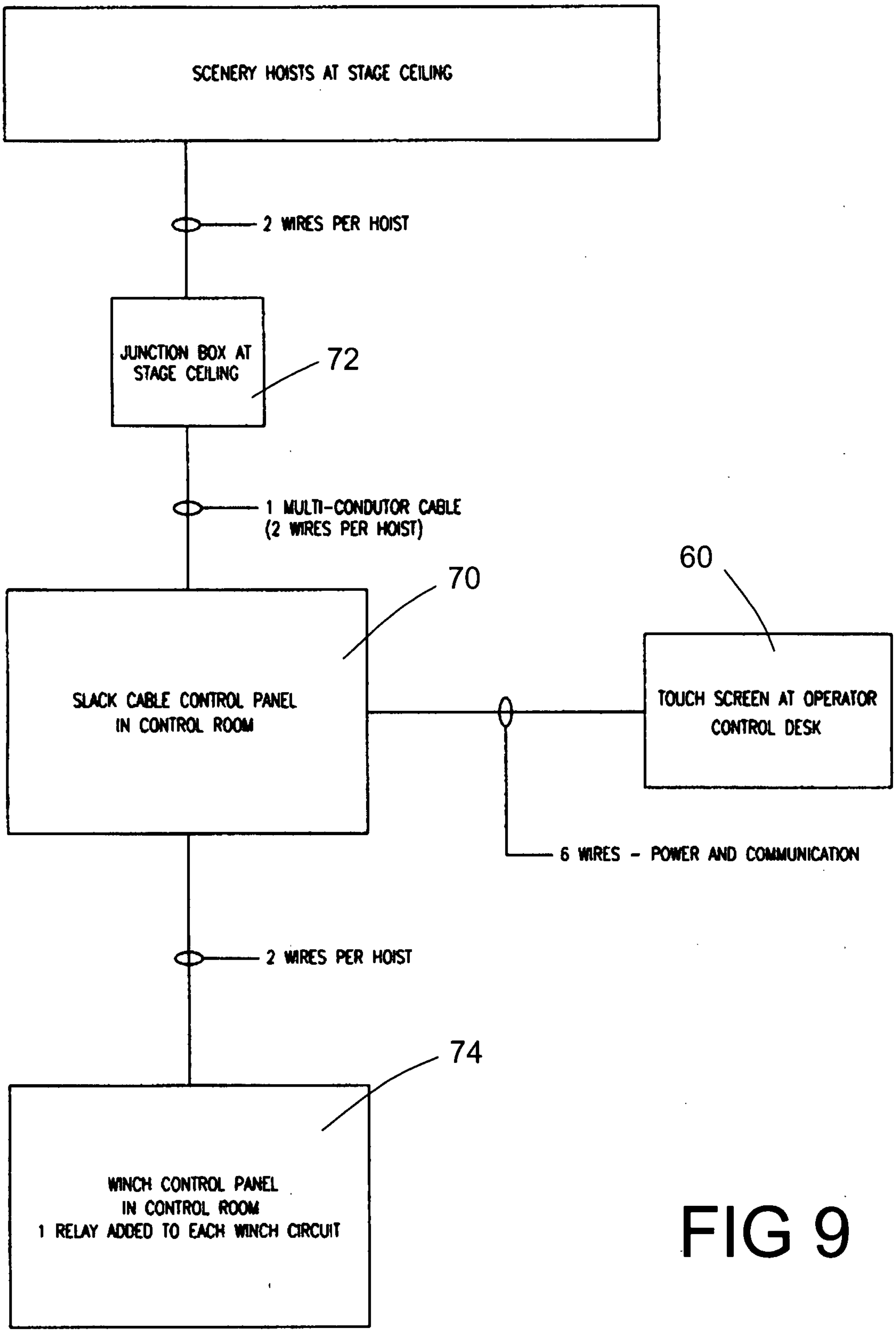

SCENERY HOISTS AT STAGE CEILING
2 WIRES PER HOIST
JUNCTION BOX AT STAGE CEILING
72
1 MULTI-CONDUTOR CABLE (2 WIRES PER HOIST)
70
60
SLACK CABLE CONTROL PANEL IN CONTROL ROOM
TOUCH SCREEN AT OPERATOR CONTROL DESK
6 WIRES - POWER AND COMMUNICATION
2 WIRES PER HOIST
74
WINCH CONTROL PANEL
IN CONTROL ROOM
1 RELAY ADDED TO EACH WINCH CIRCUIT

FIG 9